

The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

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THE CHEMICAL AGE offices are closed on Saturdays in accordance with the adoption of the five-day week by Benn Brothers, Limited

Telephone: CENTRAL 3212 (10 lines)

BIRMINGHAM: Daimler House, Paradise Street, (Midland 0784-5)

VOL. XLV. No. 1153

August 2, 1941

Annual Subscription, 21s.
Overseas, 26s.

Water Power and Electro-Chemistry

ANOTHER battle royal is promised over a Highland water power scheme in connection with the utilisation for industrial purposes of the water traversing Glen Affric and Glen Cannich. Brief reference to this was made in THE CHEMICAL AGE of June 21 (p. 344). The solution of the problem, as was then pointed out, turns upon whether Highland water power is essential to the country as a whole. There is too widespread an impression that the limited availability of water power in Great Britain excludes this country from taking part in the major electro-chemical and electro-metallurgical industries. The cheap water power obtainable in Sweden and Canada enables those countries to undertake the manufacture of certain products which we could not hope to manufacture at the same cost, and to that extent our potentialities are limited; but it must not be forgotten that the amount of chemical energy required in the manufacture of individual products now produced by the agency of electricity varies very greatly, and it has been calculated that with electricity generated in this country by steam power, the percentage of the import or selling price before the war represented by the cost of the electrical energy varies between 0.5 per cent. and more than 20 per cent. Clearly we can engage in electro-chemical and electro-metallurgical industries where the cost of energy is small compared with the selling price, provided that we can obtain the other raw materials at a reasonable price.

A secondary but still important consideration which is often neglected is that of the load factor as controlled by subsidiary operations. The efficiency of electrical generation in power stations is very low as compared with the much higher efficiency of the application of heat in other industrial operations. Many generating stations do not reach an efficiency of 20 per cent. and even the best stations have a thermal efficiency of the order only of 27 per cent. It has been computed, however, that if the exhaust steam from the turbines was used for centrally heating large buildings in the neighbourhood of the power station, the overall efficiency of heat utilisation could be raised to 60 per cent. C. S. Jeffrey (*Engineering*, December 29, 1939, p. 710) has deduced a formula showing the variation of the cost of electricity with the overall thermal efficiency of the generating station. If B is the fuel cost of electricity in pence per ton; E the thermal efficiency per cent., and C the calorific value of the coal as a percentage of 15,250 (this being taken as the "standard" coal) the formula becomes $B = P/EC$. From this it is clear that the fuel cost varies inversely as the overall thermal efficiency. Thus, if the sur-

plus heat (i.e., exhaust steam) from a coal-fired electrical generating station were to be used for process work for the manufacture of other chemicals or by-products, the cost of power could be reduced to a figure much less than that of the best generating station known to-day.

A detailed analysis made before the war by Professor R. H. Hutton and O. W. Roskill (*Engineering*, 1939) indicated that the cost of electrical energy from steam power in this country might, under the cost bases ruling at that time, fall as low as 0.161d. per kWh based on a 80 per cent. load factor and a capital cost of £18 per kW installed. This cost was compared with that obtainable from a water power plant costing £49 per kW installed, which, it was claimed, was likely to be exceeded in future installations in this and many other countries. Whether in these circumstances we should use water power depends upon the view taken of the country's coal resources. We do not know what is the probable cost of water power in the Glen Affric and Glen Cannich scheme, but it can hardly be much less than the cost of generation by steam and it is probably greater than a coal-fired station in which the exhaust steam is utilised for process purposes. The problem therefore boils down to the policy which as a nation we are to pursue in connection with coal utilisation.

It is often glibly assumed that our coal supplies are sufficient to last for 600 or 1000 years—the figure varies from time to time according to the optimism of the estimator. What is not generally understood, however, is that the cost of mining coal is becoming progressively higher. A good deal of the coal possessed by this country can never be mined because of technical difficulties in mining and must therefore be left in the pits, unless some scheme of total gasification below ground can be devised—a problem which was recently being tackled in Russia. Moreover, few of the collieries that are now being worked to-day will be in operation in 50 years' time, since they will have been worked out. This means progressively deeper and more expensive mining or mining thinner seams. Taking the long view, we should regard it as essential that all possible water power should be utilised in this country in place of coal, whether from our Scottish Glens, from the Severn Barrage, or from other sources. The Severn Barrage was reported upon favourably in 1933, but has never been undertaken. The industrial dependence of this country upon reasonably cheap coal makes it necessary that such schemes as that now contemplated should be examined with an open mind, and with due respect to their effect on coal conservation.

NOTES AND COMMENTS

The Japanese Dilemma

THE logical effect of the "freezing" of Japanese assets in the British Empire and the United States is the complete cessation of trade between the countries concerned. But whether this economic weapon will be utilised to the full depends very largely on Japan's actions in the immediate future. In fact, trade with Japan in commodities that could be classed as war materials has been very severely restricted in recent months by export licensing and kindred methods, and it is now certain that all supplies of such vital materials as nickel, rubber, aluminium, and the war chemicals will immediately cease so far as Britain and the U.S.A. are concerned. Some trade in non-military materials, especially textiles, is likely to continue, unless the Japanese show themselves to be utterly intransigent; and the oil position is dubious. Complete loss of oil supplies from abroad would be ruinous to Japan within a year and it would no doubt be possible for the British Empire and the United States to offer joint backing to the Netherlands East Indies should it become expedient to enforce an embargo on oil (and other exports) from those islands to Japan. Reports show that already Japanese manufactures from imported raw materials are showing a grievous loss: steel, for example, is down by 25 per cent. And the present domination of Indochina by Japan is little more than a recognition *de jure* of what has long been true *de facto*. Short of a rapid and victorious military campaign against Malaya and the East Indies—a difficult task for a country already exhausted by a five years' war of attrition—it would seem that Japan's only chance to avoid complete and rapid exhaustion would lie in a policy of conciliation towards her principal customers.

Minerals in Burma

IN Japan's ominous moves towards our strategic bases in the Far East it should not be forgotten that she also draws near to one of the most important sources of raw materials in the Empire, namely, Burma. The closing of the Burma Road might well be only half her interest in that country, for it is at once apparent from the review of the mineral resources of Burma, published in the April-June edition of the *Bulletin of the Imperial Institute*, that any stoppage in the production of war materials from Burma would have a serious effect on our war effort. Recent statistics show that Burma produces 84 per cent. of the Empire's wolfram, 28 per cent. of the zinc, 18 per cent. of the petroleum, 14 per cent. of the lead, 13 per cent. of the silver, and 7 per cent. of the tin concentrates, not to mention other less important minerals. During 1938 5343 tons of tungsten ore and 6303 tons of tin ore were produced in the country. The deposits are found at intervals over a distance of 750 miles and the ores are, with the exception of surface deposits, mainly produced from quartz veins. The largest producers are the Mawchi mines in the Karenni state where 4646 tons of mixed tin and tungsten concentrates were brought to the surface in 1938. The area of these mines was for long practically inaccessible, but the construction of an 80-mile road has opened them up. Almost the entire output of lead and silver comes from the Bawdwin mines owned by the Burma Corporation, Ltd. Here the total production in 1938 was 78,900 tons and 5,920,000 oz. respectively; zinc blende also occurs there. The ore reserves during the same year were estimated at 3½ million tons assaying 17.7 oz. silver per ton and 23.1 per cent. Pb, 14 per cent. Zn, and 0.94 per cent. Cu. In addition to these minerals some 263 million gallons of petroleum were produced in Burma in the same year. Of the non-metallic materials corundum, barytes, and mica are all produced but not to so important an extent.

Crises Stimulate Inventions

MORE than a thousand inventions a month have been submitted to the Ministry of Supply since the war started, and the total is now well over 50,000. It is found that about 0.25 per cent. of these are useful and worthy of development, while about 4 per cent. come from members

of the Forces and are forwarded through Service channels. It has been known for many years that the inventive faculty, or at all events the urge to bring it to the nation's aid, is stimulated by the stress of war; the average monthly total of submissions is higher, in fact, than the average yearly total of ideas submitted direct to the War Office in peacetime. What is perhaps more singular is the way in which crises or stresses within the war provide an additional stimulus to the wave of inventions. The collapse of France, it is reported, raised the monthly number of submissions from somewhere in the fifteen-hundreds to 7500; the Battle of Britain produced another maximal point with some 3700 inventions; and the monthly quantity remained at nearly double the normal throughout the heavy air-raids of last winter, only to resume its customary level when our night fighters and the shorter nights combined to reduce the incidence of bombs on Britain. We suspect, the German character and working methods being what they are, that the same reaction would not apply under Nazi rule, and it is our opinion that the phenomenon is simply another manifestation of the enormous reserve power and resilience of the British character.

Gilsonite

GILSONITE, says the *American Ink Maker* for April, is a black, brittle, lustrous mineral, consisting of hydrocarbons and named after the late Samuel Gilson, the original discoverer of the Utah deposits in 1870. To-day gilsonite is the most important asphaltic material used in the manufacture of black and brown inks and varnishes. Other uses are in the production of paints, asphalt floor-tiles, cold-moulded materials, electrical insulation, roofing, brake linings, storage battery cases, etc. It is almost completely soluble in carbon disulphide, less soluble in naphtha; it has a specific gravity ranging from 1.04 to 1.10; and a fusing point of 132° to 204° C. The Uinta Basin, an area of some 15,000 square miles in the State of Utah, is the only place in the world where gilsonite is found. The deposits occur in parallel vertical veins, varying from a few inches to several feet in width. The supply is almost inexhaustible since some of the veins have been mined for 8 miles in length and to a depth of 1200 feet. The material is dug out with pick and shovel in a manner similar to coal. A higher-quality product is obtained from the centre of the mine than near the edges or the top. The geological origin of gilsonite has not been certainly determined. It is generally agreed that it originated during the Tertiary Period of geological formation from oily vegetation-decomposition products. Resulting great heat and pressure exercised a metamorphic action on the oils, converting them into solids. Another theory of its origin is based on the inorganic formation of the petroleum from which it was made by heat and pressure. Free molten alkaline earths may have reacted with water and carbon dioxide to produce acetylides, which in turn reacted with water to give acetylenes and finally petroleum by hydrogenation.

New Zinc-Plating Method

Alkylamine Added to the Bath

THE Purdue University Research Laboratories, Indiana, have developed a new bath for electroplating with zinc, according to U.S.P. 2,245,086 awarded to J. L. Bray and F. R. Morral, of West Lafayette, Indiana. The bath is said to produce a bright, smooth, corrosion-resistant plating which does not crack even when the sheeting to which it is applied is bent. Unlike coatings produced by other zinc-plating methods, the plating resulting from the new bath is free from coarseness, crystalline structure, and the frosted appearance known as "trees." The secret of the process and bath resides in the addition to the zinc sulphate plating bath of a small amount of an unsubstituted alkylamine such as trimethylamine, which is said to yield a smooth plating by preventing the deposit of coarse zinc metal crystals on the surface being plated.

Water-Glass: its Composition and Uses

III.—Further Notes on Manufacturing Processes

by BRUNO SCHWEIG, Ph.D.

(Continued from "The Chemical Age," July 26, 1941, p. 49)

EQUALLY important is the process of solution, as water-glass is exclusively used as a liquid, and the manufacturers of the solid water-glass generally undertake the work of dissolving it. The methods of dissolving and the apparatus employed vary according to circumstances. Two outstanding principles are employed. "Alkaline" water-glass of the formula $\text{Na}_2\text{O}, 2.06\text{SiO}_2$, and other relatively easily dissolved brands are treated in stationary dissolvers. "Neutral" glass, $\text{Na}_2\text{O}, 3.3\text{SiO}_2$, and those of kindred composition are dissolved in rotary digesters.

The stationary plants are vertical autoclave cylinders without provision for mechanical agitation. They are filled from the top, first with lumps of solid water-glass, then with a diluted silicate solution supplemented by water; eventually steam of 3 to 5 atm. (45-75 lb.) pressure is introduced. The circulation must be sufficient to prevent the heavy solutions, which form first, from accumulating at the bottom of the vessel. After about three hours the process of dissolving is finished, the grade of the solution is tested and, if found to be correct, the solution is expelled by steam pressure into another vessel where some of the impurities settle. Then the solution is filtered.

The rotary dissolvers are usually horizontal digesters about 5 metres long and 2 meters in diameter, made of heavy riveted steel plate. In the middle is a hole, closed during the working, through which the dissolver is charged. Opposite is a tap with a nozzle for emptying. Through one of the bearings passes a tube by which the steam is introduced. By means of suitable gearing the digester is slowly rotated at about five revolutions per minute. The

The manufacture of water-glass by the direct fusion of common salt, NaCl , with sand would be very valuable if it could be carried out economically. The chlorine of the sodium chloride is transformed into hydrochloric acid by the addition of steam to the molten salt according to the equation:



It is, however, very difficult to distribute the steam evenly throughout the mass, and, in addition, the chlorides

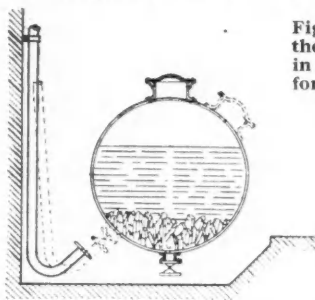


Fig. 5. Cross-section of the rotary dissolver seen in Fig. 4. The position for emptying is shown by the dotted lines

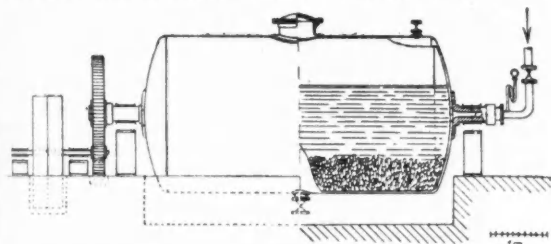


Fig. 4. Rotary dissolver for water-glass: longitudinal section

charge is similar to that of the stationary apparatus, consisting of about one-third solid water-glass and two-thirds dilute solution. With steam at about 3 atm. (45 lb.) and rotating, the dissolving takes some hours. Then the apparatus is stopped in such a way that the nozzle can be connected with an adjustable discharge pipe, and after letting off most of the steam the water-glass solution is forced out into an empty container and treated as previously described.

The filtration is not always simple. I. G. Vail and J. Carter recommend, in U.S.P. 1,132,640 (1915), a slight content of aluminium as helpful, whereas magnesium has a retarding effect. A yellow colour in the solution may be due to the presence of sulphides and organic impurities. Oxidising bleaching agents such as hydrogen peroxide, chlorine water, or hypochlorite lye are employed, and sometimes the sulphides are precipitated with copper oxide.

Another method of solution is carried out in some European countries according to D.R.P. 628,556. This is a continuous process without pressure. Hot strong solutions of water-glass, which have a strong solvent capacity, are brought into contact with the solid water-glass; and only a part of the solution is mixed with fresh water at a point in the vessel away from the solid water-glass.

are very volatile. If this process were successful and could replace the sulphate process, 360 kg. sulphuric acid, now lost as SO_2 , could be saved per ton of solid water-glass.

A more serious competitor to the classical dry methods is the manufacture of water-glass by wet processes. The basic idea here is to dissolve silicic acid in caustic soda or potash, as the case may be. Ordinary sand is hardly affected by alkali lye; it is, therefore, necessary to find suitable forms of silicic acid which are fairly easily soluble. Such sources for silicic acid are mainly diatomaceous earth (kieselguhr), flint, precipitated silicic acid (as by-product from other processes), or charred rice husks.

When kieselguhr, which is very convenient because of its large surface, is used, the earth is first calcined then stirred in small quantities into boiling solutions of caustic alkali of specific gravity 1.22-1.24. It remains there for about three hours. Often an autoclave with a pressure of 3-4 atmospheres is employed. The partial clearing of the mixture indicates the end of the reaction. After dilution

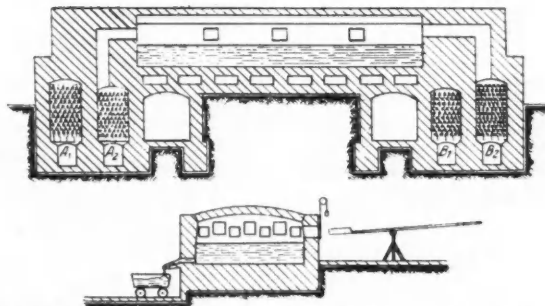
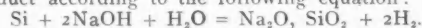


Fig. 6. Siemens-Martin tank furnace for water-glass. A₁, A₂, B₁, B₂ indicate the heat stores (see p. 49)

the insoluble impurities are separated. Flint, ground before use, is treated similarly.

Another method, called the Jaubert or Silicol Process, designed to produce hydrogen, yields silicate of soda as a by-product according to the following equation:



Though silica itself would be the most suitable material

for this process, for reasons of economy alloys such as ferro-silicon and mangano-silicon are used. During the last war the British Admiralty erected a plant for this process, but as this method is rather uneconomical, it is hardly a peace-time proposition.

Electrolysis may be mentioned as a means of preparing silicates with especially high molecular ratio, such as Na_2O , 4.2SiO_2 which are difficult to produce by other methods.

This survey of water-glass is written with a special view of the importance of water-glass in war-time. The scope of the soluble silicate has, however, already reached such dimensions and is obviously still extending, so that some manufacturers of ordinary glass may think it well worth while considering whether the change-over to water-glass production might not be opportune.

Solvent Extraction Practice

Problems Still to be Solved

GARBAGE, pine stumps, soiled clothing, and oilseeds are among the materials now handled on a large scale by solvent extraction methods introduced or radically improved within the past decade. A notable example is the American soya-bean processing industry which now uses hydrocarbons to extract about 350,000 tons of beans per annum, or more than 20 per cent. of its total tonnage, and according to W. H. Goss (*Chem. Met. Eng.*, 1941, 48, 4, p. 80) current construction indicates a continuing increase in the use of solvent extraction. It is, however, significant that high oil-recovery was a strong incentive to technical and tonnage development of solvent methods in Germany, whereas the American industry grew up round machines suitable for a decentralised system of relatively small mills located in crop-producing areas. Technological problems incident to the solvent extraction of other oilseeds are far greater than in the case of soya beans. The latter can be rolled easily into thin firm flakes which retain their structure even after the oil has been leached from them, whereas cottonseed, flaxseed and others form flakes which disintegrate when treated with oil solvents, resulting in a powdery pulp that cannot be handled in ordinary solvent systems. The solutions resulting from such extractions likewise contain mucilaginous materials defying treatment by usual methods. Major developments in the solvent extraction of the oilseeds concerned depend on the surmounting of these difficulties.

Uses of Hydrocarbon Solvents

Caffeine is being extracted from coffee by means of trichlorethylene and other chlorinated hydrocarbons; isopropyl alcohol is used to extract zein from the effluent remaining after the settling operation in wet corn milling; riboflavin is extracted from distillers' grains with butanol; and wheat-germ oil and flour are likewise being produced by means of hydrocarbon solvents. The American naval stores industry uses hydrocarbon solvents to recover wood rosin, turpentine, and many terpene derivatives from more than 1,000,000 tons of pine stumps taken yearly from cut-over land, and in newly-established tung-oil plants advantage is taken of solvent extraction to recover the last traces of oil from press cakes. Groundnut, rapeseed, palm-kernel, copra and castor-bean press cakes are solvent-extracted in European works.

Choice of solvent for a particular extraction depends primarily upon satisfactory penetration of the cell structure and selective solution of the desired substances, but it is also essential that the solvent be easily removable from the micella and from the residue, leaving both in marketable condition. Avoidance of metallic contamination of the product and of thermal decomposition or tainting may be factors of predominant importance, particularly where edible oils are concerned.

In large-tonnage solvent extraction of vegetable oils, solvent losses usually amount to from 0.5 to 1.0 per cent. of the weight of the raw materials processed. This

factor accounts for the rather general use of relatively inexpensive hydrocarbon solvents where at all possible, despite hazards connected with their use. Petroleum producers have increased their output of special solvent naphthas having very narrow boiling ranges, low evaporation residues, excellent stability and other desiderata, including low price, but the risk of explosion demands extreme care in operation. The naphtha most commonly used by the American soya-bean industry is essentially a normal hexane fraction boiling at $63^{\circ}\text{--}70^{\circ}\text{C}$., and leaving a residue of only 0.0004 per cent. by weight. Apparently the only commercial soya-bean extraction plant using any solvent other than a petroleum cut is the Manchuria Soybean Industry Company, Dairen, which uses the "hot alcohol" process, with 99.8 per cent. ethanol at 80°C . and under pressure, to deal with 100 tons of beans per day in rotary extractors. The advantages of the process lie chiefly in the ease with which by-products such as phosphatides, sugars, and saponins can be recovered, and it seems that the market for these items is a factor determining the prospects of the method. Over-supplies of edible fats and oils in the United States, coupled with shortage of all types of drying oils, lend special importance to the possibilities of separating drying and non-drying constituents by the selective action of solvents exhibiting partial miscibility.

Thiophenes in Ichthyol Oils

Compounds Isolated by New Methods

DEPOSITS of shale-like minerals from which the medicinally valuable ichthyol oils are extracted have been worked in various parts of the world for many years, notably in the Austrian Tyrol, Japan, and the U.S.A. (Texas). More recently attention has been directed to the possibility of using processed or crude ichthyol oils as sources of hitherto unknown or scarce fine chemicals. Of particular interest in this connection are the thiophenes.

As long ago as 1914 an attempt was made to develop a commercial process for extracting thiophenes from the crude shale (D.R.P. 327,050). The latter, which contains a high proportion of inorganic matter, was heated with soda lime and the subsequently separated organic fraction was reacted with an alkyl magnesium halide. Organometallic derivatives of the thiophenes were thus formed and these were decomposed and distilled over sodium, the light-coloured distillate consisting of the mixed thiophene compounds dissolved in hydrocarbons. This process has historical interest, but does not appear to have reached the industrial stage, for thiophene and its homologues are still among the most expensive items in the fine chemical catalogue.

Members of the thiophene family are, nevertheless, of definite interest as stepping stones in the synthesis of new medicinal chemicals, and it is largely on this account that Continental chemists have made a close study of the components of ichthyol-like oils. Quite recently a paper published by Steinkopf and Nitschke (*Arch. Pharm.*, 1940, pp. 360-75) describes researches on two fractions isolated from the grade of ichthyol known as Karwendel oil. The one fraction (volatile in steam) was found to contain 2,3-dimethyl thiophene, 3,4-dimethyl thiophene, 2-ethyl thiophene, 3-ethyl thiophene, 2-thiotolene and 3-thiotolene. The other fraction (non-volatile in steam) contained, among other substances, thionaphthene and dimethyl thionaphthene. Some of these compounds have hitherto been obtainable only by costly synthetic methods, so that the new methods of separation, even though the yields at present are not very high, may lead to substantial economies in production costs and so stimulate the interest of research workers in this comparatively obscure field.

The Manchester Chamber of Commerce, at the board meeting held on July 14, elected the following company to membership: F. G. Williams, Ltd., chemical manufacturers, 59 Blackfriars Road, Salford, 3.

PHENOL FROM CHLOROBENZENE

Old and New Processes of Manufacture

by G. S. RANSHAW

UNTIL the 1930's, phenol, which is one of the most important intermediates both for the synthesis of dyestuffs and for the manufacture of plastics, pharmaceuticals, and explosives, was prepared almost exclusively from benzene by way of benzene sulphonic acid, and the application of this method persists to-day although the yield is low relative to the quantity of benzene used and a substantial consumption of sulphuric acid and caustic soda is entailed.

However, the Dow Chemical Company of the U.S.A. succeeded in 1927 in making phenol from chlorobenzene, treating the latter under pressure with aqueous solutions of caustic soda. In this way the drawbacks of the older process were avoided and, at the same time, a use was found for the large quantities of chlorine accumulated in the course of electrolyzing sea-water. At present a large proportion of the world's production of phenol is manufactured by this method, which has been intensively studied by chemists in many countries and nowadays assumes considerable significance.

A Forgotten Discovery

The conversion of chlorobenzene to phenol was first accomplished by the French chemists, L. Dusart and C. Bardsy, in 1872. They treated chlorobenzene with a solution of caustic soda at 300°C. But since their result opposed the view then held that it was impossible to replace chlorine in the aromatic nucleus by any other group, their communication (*Comptes Rendus*, 1872, 74, 951) was treated with disdain (Henniger, *Ber.*, 1872, 5, 389) and was forgotten for several years. It was not until 1914 that the question was reopened by K. Meyer and F. Bergius (*Ber.*, 1914, 47, 3,155). These authors had studied minutely the reaction described by the two French chemists and had found that the best results were obtained with a 15 per cent. caustic soda solution. Higher concentrations diminished the yield of phenol owing to tar formation. Besides phenol, the oxide of diphenyl is formed in quantities which increase as the amount of soda used decreases.

In theory, 2 mols. of NaOH are necessary for each mol. of chlorobenzene:—

$$\text{C}_6\text{H}_5\text{Cl} + 2\text{NaOH} = \text{C}_6\text{H}_5\text{ONa} + \text{NaCl} + \text{H}_2\text{O}$$

but on heating these quantities for 2 hours, only 66.3 per cent. phenol is obtained, the rest comprising in large part (30.8 per cent.) diphenyl ether. It is only by increasing the number of mols. NaOH to 4 and heating for 20 hours that a yield of 92 per cent. phenol can be obtained. Operating in an autoclave and using 2.5 mols. NaOH, heating for 26 hours, the yield is 90.85 per cent. of the theoretical.

The decrease in the quantity of diphenyl oxide formed when the quantity of soda and the period of heating are increased is explained by the fact that the NaOH causes the splitting of the diphenyl ether with formation of phenolates. The period of heating may be reduced, however, by using a catalyst such as Cu_2Cl_2 . Thus, with 3 mols. NaOH, 0.15 mols. Cu_2Cl_2 and heating for 2 hours at 300°C. a yield of 84.6 per cent. phenol and 8.2 per cent. diphenyl oxide has been obtained.

Almost at the same moment two German patents were taken out (281,175 by Ichendorf, and 288,166 by Bohringer). In the first a yield of 90 per cent. phenol was claimed by heating the chlorobenzene with 3 mols. NaOH dissolved in methyl alcohol for 45 hours at 200°-230°C.; in the second the chlorobenzene was treated with caustic soda, calcium hydrate, and potassium iodide in a copper autoclave for 40 hours at 240°-250°C. and the yield was 70 per cent. of the theoretical.

In spite of the manifest advantages of the Meyer and Bergius process it did not find industrial application,

chiefly because of the necessity for enormous autoclaves and the relatively small production (200 to 250 metric tons per annum). Moreover, the necessity for resorting to a pressure of 50 to 100 atm. rendered the operation dangerous.

First Industrial Process

The first attempt to obtain phenol on an industrial scale from chlorobenzene should be credited to Aylesworth (U.S. PP. 1,213,142 and 1,213,143). Its merit consisted in the fact that he increased the temperature of the reaction to 340° or 390°C.; at this temperature the reaction of the chlorobenzene with 2.5 to 3 mols. NaOH is complete in some 16 to 60 minutes. This drastic cut achieved in the time required for the operation allowed the use of a continuous tubular reaction system which was cheaper and less dangerous than preceding arrangements and gave a greater production. According to K. Brown (*Ind. Eng. Chem.*, 1920, 12, 279), Aylesworth's installation functioned for some time, but no indications exist as to the yield of phenol obtained; it is possible that the death of Aylesworth in 1917 preceded full development.

The following improvements on this method are due to the Dow concern. Results of laboratory work undertaken by them have been published by Britton and Hale (*Ind. Eng. Chem.*, 1928, 20, 114), and in a series of patents (U.S. PP. 1,607,618, 1,737,841, 1,821,800, 1,868,401, 1,882,824, and 1,882, 826). It is possible to obtain 97 per cent. phenol at 370°C. in 30 minutes. The important innovation of the Dow company consisted in the addition to the reaction mass of a little diphenyl oxide. This succeeds in preventing the fresh formation of diphenyl ether and thus increases the yield to almost the maximum theoretically possible. Thus, by adding 12-18 per cent. diphenyl ether to the chlorobenzene in the autoclave and by using 2.5 mols. NaOH per mol. chlorobenzene a yield of 96.99 per cent. phenol is obtained. The duration of the reaction is 32 to 35 minutes.

The process described in the patent of Grisewood (U.S. P. 1,833,485) differs from that of Aylesworth in that the chlorobenzene is previously emulsified with the caustic soda, while the heating coil is separate from that in which the reaction is conducted. The formation of an initial emulsion with the NaOH is also indicated by Williams and Britton (Dow) in U.S.P. 1,756,110.

In Ullman's *Enzykl. Tech. Chemie* appears a description written by Hale of the process of manufacturing phenol in the Dow plant. This process is conducted as follows, according to U.S.P. 1,607,618. The mixture of 1 mol. chlorobenzene with 2.25 mol. of 98 per cent. NaOH and 6-8 per cent. diphenyl ether is pumped through a tubular system 2.5 cm. in internal diameter and 1.609 metres long. These tubes are heated in a bath of molten nitrite up to 370°-380°C., the pressure used being 315-350 kg./sq. cm. The length of time the reactants remain in the tube is 30-35 minutes. This, however, contradicts somewhat the facts as given by Hale in the monograph quoted above, in which it is stated that the nitrite bath had been discarded as had Aylesworth's process in general.

Russian Work on Catalysts

As quoted in the *Industrie des Mat. Col. U.R.S.S.*, 1932, 6, 245, Zelinsky and Oucharoff utilised a steel autoclave furnished with an agitator. The hydrolysis of the chlorobenzene was accomplished by the addition of diphenyl ether and various catalysts. They remark on the energetic action of cuprous and cupric oxides as compared with that of metallic copper. They obtained good yields (95 per cent.) of phenol in 25 minutes working at 320°C. in presence of copper monoxide. Unfortunately, these workers did not determine the quantity of diphenyl ether remaining after the reaction; it is difficult, con-

sequently, to say what quantity of phenol had been produced, starting with chlorobenzene and diphenyl ether.

As will readily be seen from this short review, in spite of the large number of attempts and elaborate processes devised with the object of producing phenol from chlorobenzene, there had been no effort to ascertain the exact specifications as to the best conditions for accomplishing this. The task was undertaken in 1933, however, by Vorozheff and Ochoneff working in the U.S.S.R.; they introduced strict control and determined the quantities of phenol obtained at different stages, together with the percentage of chlorobenzene that had reacted, by titration of the NaCl formed. The first trials were carried out in rotating autoclaves, capacity 1 litre, capable of resisting a pressure of 500 atm., and furnished with a special closure and apertures for thermometer and manometer. The autoclave rotated at 16 r.p.m., heating was by electric furnace, and the temperature rose to 350° C. in 60 to 70 minutes (5° per minute). At the end of the reaction the chlorobenzene and diphenyl oxide which had not reacted were distilled and separated by fractionation.

The workers cited varied the quantity of chlorobenzene, caustic soda, diphenyl oxide, temperature, and duration, also the quantity of catalyst, and concluded that the best results were obtained at about 360°-370° C. At this temperature the reaction was completed in about 10 minutes, in presence of 3 mols. of NaOH, and led to the formation of 96 per cent. of the theoretical yield of phenol. At the same time the diphenyl ether used is almost completely recoverable. If the caustic soda used is reduced to 2.5 mol. the yield of phenol is lowered, but at the same time the quantity of diphenyl ether is increased, in so far that more is recuperated than was added at the start. This is contrary to the statement of Hale and Britton (*loc. cit.*), who obtained a yield of 97 per cent. phenol with 2.5 mol. NaOH at 370° C. An increase in concentration of NaOH from 8 to 12 caused the yield of phenol to decrease a little. As to the speed of the reaction, it was sufficiently great, and in 10 minutes at 340° C. almost the same result was obtained as at 350°. As catalyst they used metallic copper which, under the action of the NaOH at high temperatures, is partially transformed into Cu₂O, an oxide possessing catalytic properties superior to those of the metal itself.

Ignition of Inflammable Mixtures

Sparks Struck from Painted Ironwork

THE Safety in Mines Research Board, in co-operation with the Factory Department, Ministry of Labour and National Service, has issued a detailed report on work carried out during recent years on the ignition of inflammable vapours by sparks from ironwork painted with aluminium paint. Firms interested may consult a copy of the original report on application to the Superintending Inspector of Factories for their district.

The report is, in fact, of such interest that in normal circumstances we should not hesitate to publish it in full; but the position with regard to paper being what it is, it is impossible to include here more than a summary of the experiments and their results.

An Effect of Rust and Heat

Sparks having been observed on occasion when steam-heated vessels or pipes coated with aluminium had been lightly struck by a metal tool, a certain firm undertook experimental work on the subject. Their tests showed three things conclusively: (a) that the effect only occurs when the iron surface before painting is rusty; careful preliminary cleaning eliminates the sparking; (b) that after being painted, the rusty specimen must be subjected to a temperature in the neighbourhood of 130° C. before sparking can be obtained. No sparks could be obtained from an unheated specimen of rusty iron painted with an ordinary oil-medium aluminium paint, though the specimen had been kept for one year at laboratory temperature before

being tested; (c) but that once the specimen has been heated after being painted, the temperature of the iron when struck has little or no effect on the character of the sparks obtained, *i.e.*, the effect achieved by suitable heat treatment persists at normal temperature.

An ingenious contrivance, enabling the operator to strike a normal blow with a tool without danger to himself was set up, by the Safety in Mines Research Board, and exhaustive tests were carried out with a number of explosive mixtures, including one so easily inflammable as a mixture of 7.5 per cent. carbon disulphide in air. It should perhaps be emphasised that, under the conditions of test applied, no spark could be struck by the impact of iron on iron, so that there can be no suggestion that the sparks caused were merely a phenomenon of metallic friction. The sparks obtained from a painted specimen were more in the nature of small flames, nearly white in colour, accompanied by a number of minute bright scintillations.

Three Types of Paint Tested

Tests were made (at varying temperatures) not only with ordinary oil-medium aluminium paint, but also with cellulose-base paints and paints containing a coal-tar base, fourteen types in all being chosen. An analysis of the results shows generally that the oil-medium painted samples, after 24 hours' heat-treatment at 125° C., will show feeble sparks when struck, but that the "flames" described above do not appear unless a temperature of 200° C. has been maintained, in which case the paint begins to show signs of flaking off. With the cellulose paints the danger temperature appears to begin at about 250° C. and is marked at 300° C.

Except in one instance (called "paint No. 1"), all the specimens when dry after painting had a complete covering of aluminium which was attached tightly to the iron. It would not rub off and left no trace of aluminium powder on the fingers when touched. After heating to 200° C. and upwards the linseed-oil paints were somewhat flaky and it was possible to rub off aluminium flakes. This disintegration was the more pronounced the higher the temperature to which the samples had been heated. This loosening of the aluminium under heating was also noticeable when cellulose-base paints were used, but was not so marked at a given temperature. The effect of heating on coal-tar-base paints was less marked still. That all paints were affected in the same way, but not to the same extent, and yet had widely different chemical compositions suggests that the explanation of the phenomenon is purely physical. It is suggested that it is due to the loosening of the rusty aluminium layer from the underlying steel during expansion under heating, that loosely attached flakes are made which under impact reach a high temperature and start a miniature "thermite" reaction. In support of this view paint No. 1 gave ignitions easily without heating and it was also flaky. The linseed-oil paint became flaky at temperatures from 150-250° C. The cellulose base paints contain a plasticiser, dibutyl phthalate, which boils at 227° C., and it is not, therefore, surprising that the plasticiser's effect is not completely removed up to 300° C. The coal-tar paints are mixed with materials distilled between 200-300° C. and it is not, therefore, surprising that they are very stable up to 300° C.

Shipping difficulties in the Far East have not improved the position of Java as an exporter of molasses. Local storage tanks, it is reported, are now full and this year's sugar crop is expected to yield 375,000 tons of molasses. Efforts are being made to dispose of the surplus by preparing solid molasses, which can be exported in bags, and by increasing domestic methods of consumption. Among the latter possibilities are: The making of a substitute for coke, using molasses and cane waste as raw materials; the production of a marketable potassium salt from molasses; using larger quantities of molasses in the manufacture of bakers' yeast; the preparation of acetic acid; and increased production of alcohol. Production of acetic acid, however, depends upon apparatus made of materials not now procurable, and the expansion of alcohol production implies a larger export market.

LETTER TO THE EDITOR

Light Metal Fires

SIR,—In the Metallurgical Section of THE CHEMICAL AGE for July 5 there is a statement in the article "Explosions from Metallic Dusts" which says: "At present no safe and satisfactory method can be recommended for extinguishing a large fire involving aluminium, magnesium, or zinc powder." On p. 5 of the same issue there appears a letter from us which gives information of a material we produce for extinguishing such light metal fires, whether they originate in powder, swarf or in certain special conditions (*e.g.*, magnesium incendiary bombs) in solid magnesium alloys. As, therefore, this seems a contradiction, we should like to make a few comments on the subject of extinguishing light metal fires.

We have discovered that magnesium powder fires are easier to create than fires in aluminium powder and that the difference in temperature is considerable: aluminium powder burns with much greater heat and in a totally different manner. A fire in magnesium powder merely burns on the surface and rapidly oxidises. The magnesium oxide thus formed is an excellent thermal insulator. Aluminium powder burns slowly at first until the surface becomes incandescent in patches and these patches then burn downward throughout the mass. By covering these fires with our "DX" Powder an oxygen-excluding coat is formed and after partial hardening of this coat is reached it can be removed and the unburnt metal and powder recovered for future use. In the case of magnesium powder 3 to 5 minutes, according to the size of fire, is necessary, but with aluminium powder we have had to wait 24 hours before opening up.

We have discovered that in powder or swarf fires the extinction can be accelerated by mixing "DX" Powder and the burning metal together. This is used only where unburnt metal recovery is unnecessary and would not be carried out with aluminium powder.

We cannot agree that small fires can be extinguished with sand or rock dust—this is a common fallacy and we must emphasise that such fires can only be controlled so that they burn out and do not spread. Such a procedure cannot be used on machinery, but "DX" Powder is made so that machinery is unharmed.

While we agree that with a very large fire the use of sand can cause a silicate explosion, our experience in mixing, described above, is opposed to the statement that burning powder must not be disturbed.

There is a varying number of factors governing light metal fires for which too much space would be required for us to comment upon fully, but exposure to air, sunlight, and moisture causes reaction in such metals, and the liberation of oxygen and hydrogen as well as the generation of heat. Storing aluminium powder in air-tight drums does not prevent spontaneous combustion; we have known of a shipment abroad opened on arrival and found to be merely a black powder—the results of such combustion—although no outward signs of heat were visible.

Proper safety precautions when machining or grinding light metals and light metal alloys have to be followed and if these are correctly observed large fires will not be experienced and consequently explosions in the open air will not arise. Where fires do occur during machining the immediate and correct application of our "DX" Powder will extinguish them, without harming machinery or the operator, and will enable unburnt metal to be recovered. Contrary to common belief, magnesium in the solid form cannot be ignited any more readily than cast iron of similar size and section, but if such magnesium does become ignited the application of "DX" will immediately solidify molten magnesium and effect extinction.

Explosions arising in machinery, *e.g.*, in the exhausters and receivers, are provided for by special arrangements in such and do not come within the scope of "DX."

Yours faithfully,

for Durston, Lang & Co., Ltd.

G. HAROLD DURSTON,

Harrow Weald, Middlesex, Technical Director.

July 24, 1941.

Chemical Matters in Parliament

Malayan Minerals for Japan

IN the House of Commons last week Mr. Gallacher asked the Under-Secretary of State for the Colonies (1) the figures for the exports of iron-ore from Malaya to Japan for 1940 and to the last convenient date in 1941; and (2) whether, in view of the fact that the whole production of bauxite in Johore in 1939, to the extent of 84,387 tons, was sold to Japan, these exports of bauxite continue; and what were the figures for 1941 to the last convenient dates.

Mr. Shakespeare stated in reply that it was considered prejudicial to the public interest to publish statistics of the exports of raw materials of war importance from the Colonial Empire, and he could not, therefore, give the statistical information desired. The answer to the first part of the second question was in the affirmative. In reply to a further question from Mr. Gallacher as to whether His Majesty's Government was still exporting essential war materials to Japan, Mr. Shakespeare said that the general policy was that such export was limited to a peace-time standard.

Non-Ferrous Scrap

Mr. Stokes asked the Parliamentary Secretary to the Ministry of Supply whether he could give any estimate of the stocks of second-hand non-ferrous scrap metal in this country, and what steps he proposed to take to reduce these stocks to normal.

Mr. Harold Macmillan replied that according to returns made by 220 merchants and 30 ingot makers, the stocks of copper, brass, and other copper alloy scrap amounted to some 24,000 tons on May 31. These stocks were not unduly large in view of the present scale of manufacturing industry. The Ministry of Supply encouraged the use of a proportion of scrap metal wherever practical, and had undertaken to buy low-grade ingots of copper and brass.

Trichlorethylene

Mr. Hall-Caine asked the Parliamentary Secretary to the Ministry of Supply whether, in view of the Consumer Rationing Order, 1941, and the necessity for conserving clothing, he would consider allowing dry-cleaners supplies of trichlorethylene cleaning solvent in excess of the present quota of 40 per cent. of pre-war usings so as to enable the dry-cleaning industry adequately to fulfil the demands of the public for dry-cleaning.

Mr. Harold Macmillan said that arrangements had already been made which provide that, as from July 1, dry-cleaners would be able to secure supplies of trichlorethylene equivalent to 60 per cent. of their normal consumption.

Location of Industry

Control of Factory Premises

AN Order—The Location of Industry (Restriction) Order, 1941—has now been made and will come into operation immediately. The Order provides that no person may, without a licence issued by the Board of Trade: (1) carry on at any factory or warehouse having an area of 3000 or more feet super any trade or business not carried on there previously; or (2) carry on at other premises having an area of 3000 or more feet super, whatever their previous use, a business of production or storage.

The Order does not apply to shops or to new buildings and a general licence is being issued providing for the use of premises for temporary storage purposes without a specific licence. Special consideration will be given to applications by firms dispossessed by enemy action or through other causes outside their control, to use alternative premises near their former place of business.

A memorandum explaining in more detail the scope and purpose of the Order and the method of applying for a licence is available either from the Headquarters or Regional Offices of the Control of Factory and Storage Premises, Board of Trade, or from local Chambers of Commerce. Copies of the Order (S.R. & O. 1941, No. 1100) will be obtainable on August 5.

Personal Notes

PROFESSOR W. M. CUMMING, of the Royal Technical College, Glasgow, has been appointed a director of the Glasgow Chamber of Commerce, representing the Society of Chemical Industry.

MR. CYRIL EDWARD LLOYD, M.Inst.C.E., who as the Government candidate in the by-election at Dudley, Worcs. on July 23 was returned to Parliament with a majority of 1365, was president of the National Federation of Iron and Steel Manufacturers in 1925 and a member of the U.K. Sugar Industry Inquiry Committee in 1934-35. Mr. Lloyd was M.P. for Dudley from 1922 to 1929, when he was defeated by Mr. Oliver Baldwin; the present vacancy was caused by the death on active service of Mr. Dudley J. B. Joel.

Obituary

MR. FRANK PROUT, of Worsley, near Manchester, who died recently, was managing director of Lancaster and Tonge, Ltd., ironfounders, brassfounder, and chemical engineers, of Pendleton.

MR. JOHN GUNTER FAIRGRIEVE, who died recently at his home in Cambuslang, Lanarkshire, was assistant works manager at the Clydebridge steelworks of Messrs. Colvilles. He first joined the firm 22 years ago as chief chemist at the firm's Dalzell works in Motherwell.

ALDERMAN JOHN H. SMITH, M.A., J.P., who died on July 25 in a Liverpool nursing home at the age of 78, rose to the position of labour manager to the group of works belonging to the United Alkali Co. He retired from active participation in the chemical industry in 1930 after 35 years' service, dating from 1875 when he joined the Hutchinson works as a lab. boy. He was a founder member of the Widnes Chamber of Commerce and was elected to the Town Council in 1917. Later, he became a county alderman and in 1938 he received an honorary degree from Liverpool University.

New Control Orders

Machinery and Plant

UNDER the Machinery, Plant and Appliances (Control) (No. 4) Order, 1941 (S.R. & O. 1941 No. 1063, price 1d.), published to-day, new classes of machinery, plant and appliances subject to licence by the Board of Trade are added to those listed in the Schedules to previous Orders, and certain of the classes already included are amended. Further, it has been laid down that machinery, plant and appliances may be supplied without licence under the Orders to a public utility undertaking when such supply can be made only with the licence or under the authority of Government Department.

Application forms for licences to acquire machinery, plant and appliances falling within the Schedules to the Orders may be obtained from the Industrial Supplies Department (Machinery Licences Division) Board of Trade, 146 Tavistock Square, London, W.C.1.

Chrome, Magnesite, Wolfram, Dolomite, and Bonding Materials

The Minister of Supply has made the Control of Chrome, Magnesite, and Wolfram (No. 2) Order and the Control of Foundry Bonding Materials (No. 1) Order, both of which came into force on July 30. The first mentioned Order makes subject to licence the acquisition and disposal of "basic or neutral refractory material," defined as including bricks, refractory cements and other refractory materials containing any compound of magnesium or chromium, other than those manufactured wholly from dolomite.

The Foundry Bonding Materials Order subjects to licence the acquisition and disposal of bentonite and col-bond, and fullers' earth, except for the following uses (ex-empted under Direction No. 1 under the Order): dyeing and processing of textiles; oil or fat purification; paint and

pigment industry; paper or board making; pharmaceutical preparations.

In addition to the materials covered by the above Orders the Chrome Controller will in future be responsible for the production and distribution of dolomite. It is not considered necessary at the present time to regulate the sales of dolomite by licence. Any inquiries should be addressed to the Chrome Ore, Magnesite and Wolfram Control, Ministry of Supply, Broadway Court, Broadway, London, S.W.1.

Export of Iron, Steel and Chemicals

Under a Board of Trade Order which is to come into force on August 14, licences will be required to export to all destinations certain additional manufactures of iron and steel, and further types of electrical measuring instruments. The Order (S.R. & O. 1941, No. 1072) also prohibits the export without licence of antimony oxides and hydroquinone, metol and mixtures containing either or both of these materials and extends the existing prohibition in respect of asphalt, bitumen and pitch (whether natural or not), and certain mixtures of waxes. Copies of the Order will be available at H.M. Stationery Office, on August 5.

Glass in Concrete

Reinforcement Suitable for Static Loads

THE use of glass instead of steel for reinforcing concrete was developed by Mr. A. W. Soden, A.R.I.B.A., and Mr. J. A. Lincoln, and, reports *Engineering* (150, 3899), has been subjected to preliminary tests by Dr. W. S. Marshall, A.M.Inst.C.E., at the City and Guilds College, South Kensington. These tests showed that glass should not be used as reinforcement when impact loads are likely but confirmed that for static loading glass makes a suitable reinforcement. Also it was demonstrated that there were limitations in the length of the glass strips available for reinforcement, and some further investigations, aimed at overcoming this and other difficulties, have been completed by Dr. Marshall. The objectives were: to determine the resistance moment of beams 12 in. by 7 in. and 9½ in. by 4½ in. in section; to determine the "lap" required for glass reinforcement; and to design a beam of long span using short lengths of glass with the lap previously determined and to test such a beam. The concrete used throughout the tests was a mixture of rapid hardening Portland cement, well-graded clean river sand, and Thames ballast in the proportion of 1 : 2 : 3. For concrete between the glass strips a ¾ in. aggregate was used. The glass reinforcement consisted of various lengths of strips up to 9 ft. long, ¼ in. thick and 4½ and 5½ in. wide. In a cross section of concrete 12 by 7 in., 4 to 8 strips were used. These tests confirmed the earlier experiments with regard to static loading: a notable feature was the consistency of the behaviour of the material. The lap tests indicated that 2 ft. was sufficient lap for the glass used in these beams. There was a tension failure, the fracture section occurring in each case at the end of the lap, and it was shown that the ultimate resistance moment of a glass reinforced beam can be expressed empirically by the formula $M = 1250 td^2$, where t is the total thickness of glass plates used and d is the depth of the beam measured to the edge of the glass reinforcement.

Unrestricted and indiscriminate use of vitamins

was criticised at Pittsburgh recently by Dr. Russel M. Wilder, when he said that the nutritional aim should be to restore to basic foods the vitamins lost in processing, rather than trying to improve on nature by putting vitamins into foods which do not naturally contain them. Dr. Wilder, who is chairman of the committee on foods and nutrition of the U.S. National Research Council, would like to see edible fats, polished rice, refined sugar, and corn meal "restored" by the addition of the vitamins lost in modern processing. He reported that the ultimate aim of the Council was a white flour in which all the elements would be retained and which would make enrichment unnecessary.

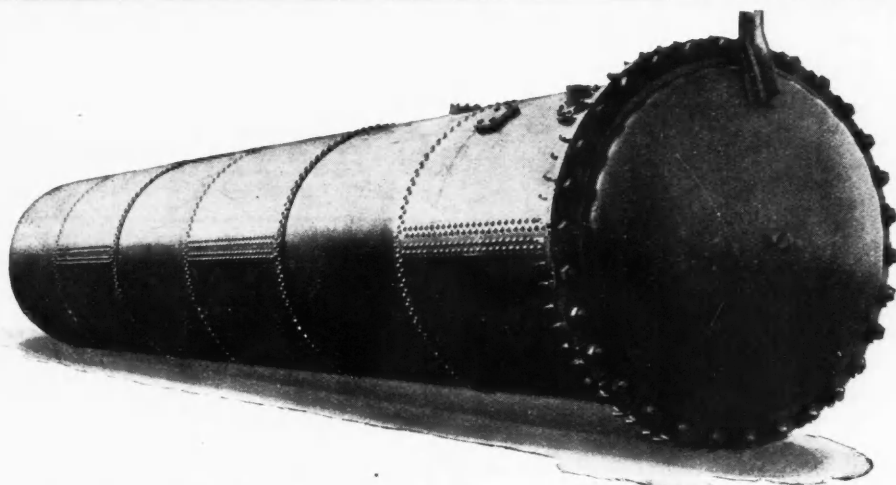
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Metallurgical Section

Published the first Saturday in the month.

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Analysis of High-Silicon Irons

Bromine and Hydrobromic Acid as Reagents

IN an effort to discover a method for the determination of silicon, phosphorus, and manganese in acid-resisting high-silicon irons, which would avoid the tediousness of the usual methods by acid attack or by alkali fusion, J. B. Cotton employed liquid bromine and hydrobromic acid as a reagent (*Analyst*, 1941, 66, 784, p. 286). The aim was to find a reagent that would dissolve the iron completely, effect dehydration of the silica in one operation, and produce a solution that could be used for the determination of phosphorus and manganese.

The most economical quantities consistent with optimum conditions were in the ratio of 1 ml. liquid bromine to 10 ml. hydrobromic acid ("Analar" 46-48 per cent.). The bromine can be quite safely poured into the acid. A 5 gm. sample, crushed and sieved to the required size, is weighed into a dry beaker and 10 ml. of the stock solution poured on. Free bromine is expelled by warming on a sand-bath and copious fumes of hydrobromic acid are evolved. After settling, the residue is digested for 2 minutes with 5 ml. conc. nitric acid, diluted to 50 ml. with water and poured on to a filter-paper through which the clear liquid has previously been decanted. All traces of iron are washed from the paper with 40 per cent. HCl and with hot water, the paper and contents are ignited in a platinum crucible, and the purity of the residual silica ascertained by treatment with hydrofluoric and sulphuric acids.

For the determination of phosphorus and manganese it is more convenient to start with fresh 1 gm. samples of the iron on to this, 15 ml. of the stock solution are poured, and the free bromine expelled as in the determination of silicon. The beaker is then removed from the sand-bath, and conc. nitric acid is added, dropwise. This must be done carefully, as vigorous effervescence takes place and

bromine vapours are formed. When the reaction has subsided, the contents of the beaker are gently boiled until free bromine is no longer evolved. The beaker is again removed from the sand-bath and more nitric acid added until all bromide is decomposed and all free bromine boiled off. The solution is diluted to 100 ml., and the silica and carbon filtered off and washed with the minimum amount of hot water until free from acid. The filtrate is reserved for the determination of manganese, or of phosphorus, by the modified methods standard in steel-works analysis practice.

It has been noted that some other types of alloys which normally resist solution in acids are dissolved by the hydrobromic acid and bromine reagent. For example, the analysis of ferro-molybdenum, and a complex alloy containing iron, silicon, tungsten, molybdenum, nickel, and chromium has been facilitated by use of this reagent.

SOUTH AFRICAN STEEL

The Iron and Steel Industrial Corporation, Ltd (Iscor), South Africa's largest steel producer, has completed plans to increase its present output of pig iron and steel ingots by about 30 per cent. through the elimination of bottlenecks in its coke and casting departments.

Upon the completion of Iscor's third blast furnace, its capacity will be doubled. All the refractories, 90 per cent. of the plates and structural steel, and many of the mechanical parts and electrical cables utilised in the construction and equipment of the new furnace are of South African origin.

Among the features of the new furnace are automatic control of charging, and increased stove efficiency whereby gas can be released for general heating purposes in coke ovens and elsewhere throughout the works.

Metallurgical Section

August 2, 1941

BRASS TURNINGS OF POOR GRADE Their Treatment and Recovery

by G. C. DOWNIE

ALTHOUGH a fair amount of information has been published on methods for reclaiming brass from mixed turnings swept from engineering-shop floors, comparatively little is forthcoming on the means of recovering brass when present in a large proportion of iron and steel, a state of affairs that not infrequently arises where operations are hastily performed.

The reason for this is that it is often considered not worth while to institute reclamation systems in view of the very large preponderance of ferrous metals present. Magneting machines are of great value for dealing with what might be termed ordinary mixtures, where a reasonable proportion of the mass consists of copper-bearing material. When, however, only some 1 to 5 per cent. of the mass consists of brass, etc., the machine is put to practical difficulties, since although it attracts the iron particles, these are usually, of too curled a disposition to allow the brass to become disentangled. Hence the only means of making anything resembling a perfect separation is to repeat the treatment several times, and even then a close scrutiny of the magnetized section will reveal brass particles still present. Efforts were made, following the large accumulations of mixed turnings after the last war period, to introduce various shaking principles to the design of magnetors, so as to relieve this adhering tendency, but these were only partly successful. As a general rule, where iron turnings have a small admixture of brass, the separation is somewhat simplified because the graphite usually causes the turned particles to break under the tool, and even where only 1 per cent. of brass is present, it is possible to attain some success with direct magnetizing.

Steel, being more resilient and springy in disposition, tends to form curled turnings, and the same applies to borings, and even to chips from most milling operations. It was during the last war period that the general desire to speed up munition production gave rise to the accumulation of excessive collections of mixed floor sweepings, which were unceremoniously swept aside, without regard to their condition. Although somewhat uneconomic, it is possible that the same rapid system may be revived under the present circumstances, particularly where most machines are engaged on iron and steel, and only a few on brass, gun-metal, etc.

Recovery of Waste Copper

The presence of a small percentage of copper in the turnings renders the metal unfit for use in the foundry or steel works, and even now such material is thrown out as waste, as the very small percentage of richer metal is not considered worth the labour of recovering. It is of interest to note, however, that almost irrespective of the sparseness of the copper content, reclamation is possible, if the waste metal receives the appropriate treatment.

Where large smelteries exist such as are erected in the U.S.A. all engineering shops in the district can take advantage of them and despatch their turnings. These fetch a small price, which in some cases is paid annually on the basis of copper recovered, no payment being made for tin or other associated base metals which may be present. Similar large smelteries are less common in this country, but an improvised system, copied from the

smelters' methods, was adopted here, although it had later to be abandoned from lack of supplies at the period of trade depression. The poor-grade turnings are regarded in the same light as poor copper ores, and on the large scale are introduced to blast furnaces where foul slags are treated. The modification of the process consists of adapting a cupola to function in the same manner as a blast furnace. Although the cupola lacks water-jackets to keep the mass cool in the vicinity of the tuyères, by dint of careful handling of the charges, excessive temperatures need not be required. This relates to keeping a surplus of poor-grade iron and brass turnings on hand to mix with parcels mostly composed of steel, which would be difficult, or almost impossible to melt satisfactorily.

Method of Charging

When the cupola starts operations, slags alone are run through it, which ensure the lining being well and uniformly heated up. Brass slags from reverberatory smelting are best for this purpose, as a small percentage of copper is recovered in any case. The charge used comprises suitable proportions of mixed iron and brass turnings and steel and brass turnings, a small addition of pyrites, and reverberatory brass slags, which last may be replaced when unavailable by re-using slags obtained from the melting. The method of charging is important for successful working, the mixture of turnings being introduced first, then a shovel of pyrites sprinkled over the mass, and finally the slags on top, but care has to be taken that the layer of turnings does not become too dense, as otherwise a choking of the blast would result, with cooling down of the furnace. Some furnace attendants believe in placing a solitary lump of slag between the mass of turnings to institute a certain splitting-up action, but it is mistaken practice to allow slags to be the first addition, since although the furnace at first sight appears to be working much more easily, most of the slag is running off without doing useful work, and leaving a soft semi-melted mass to accumulate above, and this in extreme cases has eventually to be drawn down mechanically. What happens within the furnace is that, although iron possesses a greater affinity for the sulphur of the pyrites in the ordinary way, the method of applying the blast reverses the reaction, and the copper connects first to the sulphur, whereby a crude matte, or sulphide of copper and iron is formed distinct from the iron. Although the pyrites contains some 54 per cent. sulphur, 36 per cent. of this is combined with the iron of the pyrites, and only 18 per cent. remains free to combine with the copper. Unless the blast is properly applied, the necessary oxidising conditions to reverse the reactions will not be obtained, and the free sulphur will be dissipated through the mass, and simply result in an agglomerated mass of iron and copper combined, through the medium of this sulphur. Such metal is of little value for casting purposes in the foundry, while the presence of sulphur reduces it to the poorest class of brittle material, which although it may take a sharp cast in the mould, could find little sound industrial application. For this reason care is taken in the manipulation of the charges to see that oxidation is properly controlled, and proceeds uniformly and smoothly throughout the day's work, without any intermittent changes. By so doing, the products are

obtained in three distinct layers, namely, slag, matte, and iron, while the last, although containing a few points more than the average sulphur content, can at least be utilised for coarser types of casting, *i.e.*, where a brittle disposition is not of so much importance.

Effect of Brass-Rich Sweepings

The reason for this is that the original mixture contains much in the way of steel turnings rarely exceeding the usual 0.050 per cent. of sulphur. The process is not applicable where the sweepings are rich in brass, as these would necessitate an appreciable addition of pyrites to form into matte, and would be more liable to pass any little sulphur excess on to the iron, despite the surplus air present. The specific gravity of the matte approximates to 5 as compared with from 7 to 7.5 of the iron, but separation does not accrue as is customary in smelting practice with ores, since the molten sulphur offers a connecting link to the molten iron. It is not, therefore, possible to tap off the matte as distinct from the iron, although the slag is run off from the slag-hole in the customary manner. What happens is that the molten mass, principally composed of iron, is run into the ladle, and allowed to lie undisturbed for a short period, whereby the matte rises to the surface. By using a spout on the ladle which can be kept temporarily closed, and is several inches from the usual surface which the metal takes, the top part of the mass alone is run off. This contains the matte together with that iron which has been closely associated with it. The iron is then removed in the ladle to the foundry for making into odd castings, while the top section is allowed to cool, after which the matte is broken off with the aid of hammers.

There is more in this process than meets the eye, and it is known that attempts at working it by inexperienced furnace attendants have resulted in failure, as agglomerated masses resulted. The ideal slag for the work consists of approximately 36 per cent. iron oxide, 32 per cent. silica, and 32 per cent. lime, *i.e.*, where alumina is absent.

During this process much of the tin present in the gun metal is lost, partly due to direct volatilisation, but more particularly because it forms a highly volatile sulphide with the sulphur of the pyrites. An examination of the slag reveals that lead appears to be partly converted to silicate, probably because the small excess of pyrites is insufficient first to combine, and then set it free from the matte in metallic condition, while most of the zinc present is dissipated by direct volatilisation.

Prevention of Excess Sulphur

Should the resulting matte contain within about 15 per cent. of copper, it is returned to the cupola and used in place of fresh pyrites, which is particularly advantageous where the turnings from the machine shop are known to be very low in brass content. The reason for this is, in the first place, that it obviates the presence of undue excess of free sulphur which could pollute the iron, while secondly it provides a richer matte. In earlier years, patents were taken out on methods for forming mattes, and also agglomerated metal mixtures which included sulphur, but it is doubtful whether these were put to the foregoing use. Attempts at applying the process to rich mixtures of turnings, *i.e.*, those containing large percentages of brass and gun-metal, did not meet with success, since apart from the possible pollution of the iron with sulphur, a high zinc content can lead to complications. After the last war period, one firm which specialised in treating mixed turnings adopted the oxidising principle, and had the material charged on to reverberatory hearths, together with buffings, and grindings known to be rich in siliceous matter. By the method of exposing the molten mass to excess air, the iron became oxidised, and the silica combined with it, converting it to slag, after which the copper alloy, which had accumulated at the bottom, was tapped off. In the light of recent research, the wastage of iron in causing it to be all lost to the slag might come in for serious criticism, although it held the advantage that the product recovered was a metallic alloy. With really poor mixtures of turn-

ings, it is doubtful whether the fuel consumed would allow the process to be a paying proposition.

In the process described, turnings are always recognised as being difficult material to melt satisfactorily, and the means of converting them to a metal which can be cast, despite the large proportion of slag necessary, is understood to pay the costs of the work alone, while the copper accumulated in the matte is recovered as an extra. Mattes of the kind are purchased by regular copper smelters who reclaim the metal values, but where a sufficiency justifies the expense, conversion to metallic copper can be carried out with the assistance of a small roaster and an oil-fired melting furnace. Part of the matte is roasted, then mixed with unroasted matte, and the whole charged into the oil-fired hearth, the products from which are slag and crude copper. The latter can be sufficiently refined to be utilised in the brass foundry for most compositions.

A review of the subject will reveal that the work is an intermediate between foundry and smelting practice, of which the latter found popularity after the last war period for other processes that may again be revived. In the intervening years, it has transpired that the few firms who could get rid of machine-shop turnings of the kind had them transported abroad, after a sufficient collection had accumulated. When the price of copper fell, however, even that outlet was restricted. At the present time it is possible that all poor-grade material will be reclaimed with a view to conserving copper, whilst the fact that it can be dealt with directly means that no time need be lost in the machine shop in making arrangements to discriminate between one class of turnings and another.

Standard for Wrought Steels

Important Rationalisation Scheme

THE steel industry has just effected a very important and far-reaching piece of rationalisation to which effect has been given by the British Standards Institution issuing a new schedule of wrought steels (B.S. 970), covering 58 steels, which will be known as the "En" series of steels. The rationalisation has been essentially the work of a committee known as the T.A.C., under the chairmanship of Dr. W. H. Hatfield, F.R.S., which has been acting as the advisory committee to the B.S.I. in these matters. Over 2000 specifications of Government departments and private users have been analysed, and it is considered that the needs, not only of the armament industry, but of industry generally, can be adequately met by the 58 new British Standard Specifications now published. Together with the specification, the B.S.I. is publishing a report of the T.A.C. (B.S. 971) describing the steels and giving very interesting and useful information about their characteristics. Details of heat treatment and of the important problem of the influence of mass effect are also provided and will prove extremely valuable to designers.

B.S. 970 is now available from the British Standards Institution, 28 Victoria Street, London, S.W.1, at a cost of 5s. 5d. nett (post free). B.S. 971 will be available in about two weeks' time and will be sold at 7s. 6d. nett, 8s. post free.

NEW AMERICAN TIN SMELTER

Operations for the construction of the only tin-smelting plant in the United States began late in May last at Texas City, Texas, and it is now estimated that the smelter will be ready to start production early in 1942. The plant is being built by the Tin Processing Corporation, of New York, a subsidiary of the well-known Dutch company, the N.V. Billiton Maatschappij which, from 1929, operated at Arnhem a successful process for refining Bolivian tin ore. The new plant will produce, also from Bolivian ore, some 18,000 tons of tin per annum and will have a capacity equivalent to one-fifth of United States tin requirements. The cost of the plant, expected to be about \$3,500,000, is being borne by the Reconstruction Finance Corporation.

High-Duty Cast Irons

Reports from the Institution of Mechanical Engineers

THE Institution of Mechanical Engineers, through its Research Committee on High-Duty Cast Irons for General Engineering Purposes, has issued two more External Reports to meet the demand for information on high-duty cast irons. The first, No. 218, deals with "Phosphoric High-Duty Irons," and the second, No. 219, is on the subject of "Austenitic and Martensitic Irons"; both have been prepared by Mr. J. G. Pearce, M.Sc., M.I.Mech.E., director and secretary of the British Cast Iron Research Association.

The iron ores most abundant in the United Kingdom, states the first report, are phosphoric. Hence the cheapest and most readily available cast irons are the phosphoric irons containing up to about 1.8 per cent. of this element for the pig and about 1.4 per cent. for the cast irons. The war demands the fullest use of home resources, and accordingly the need has arisen for the employment of what can conveniently be called phosphoric high-duty irons involving the adoption of the highest phosphorus contents with specified strengths and with service requirements. The report is confined to the consideration of plain grey cast iron not specially processed or heat-treated, without alloy additions, and intended for use in the as-cast condition.

The Effect of Phosphorus in Iron

The structure of an ordinary engineering iron consists of a matrix of pearlite or pearlite and ferrite, broken up by graphite flakes. If phosphorus is present in the iron, another structural constituent appears, a microscopically fine conglomerate into one of the two parts of which the phosphorus enters. This constituent is a binary eutectic obtained from what was at solidification a ternary eutectic of γ -iron, iron carbide, and hard and brittle iron phosphide. By controlling the composition of a phosphoric iron it is possible so to direct the solidification of the phosphide eutectic—which is the last constituent of the melt to solidify—that the most beneficial or least harmful distribution of phosphide results. The phosphide compound is then distributed as a network throughout the matrix.

Phosphorus, like silicon, lowers the capacity of the melt to hold carbon in solution at solidification. As the phosphide eutectic melts at a lower temperature than the remainder of the metal, phosphoric irons solidify over a wider range of temperature than the non-phosphoric irons. This sets up conditions which may result in shrinkage defects. The carbon content that a given cast iron is able to hold in solution at solidification, is known as the eutectic carbon content. To ensure adequate (not necessarily the maximum possible) mechanical strength and internal soundness, the carbon present in an engineering cast iron should never exceed this in value, and should preferably be below it. The actual figure is influenced by the amount of silicon and phosphorus present.

Values of Ultimate Stresses

In melting ordinary mixtures of pig iron and scrap, the tensile, transverse, and fatigue strengths and transverse deflection normally increase uniformly as phosphorus increases, to a maximum at about 0.35 per cent. phosphorus. As the phosphorus increases beyond this point, these values uniformly decrease in such a way that the figures for irons containing 0.65 per cent. phosphorus are about equal to those obtained for phosphorus-free material. As the phosphorus increases beyond 0.65 per cent. the figures continue to fall. The ultimate tensile stress may be expected to improve about 2.5-5 per cent. for each 0.1 per cent. of phosphorus added to a non-phosphoric iron, up to a maximum of 0.35 per cent. phosphorus, and then to diminish at a similar rate. The ultimate transverse stress is usually slightly more erratic.

The Brinell hardness number of plain cast iron increases uniformly with increase in phosphorus content, and a rise of about 4 points may be expected for each 0.1 per cent.

phosphorus added to a non-phosphoric iron. Impact or shock strength diminishes with increase in phosphorus content, and the shock strength of a phosphorus-free iron may be expected to be reduced by about 5 per cent. for each 0.1 per cent. of phosphorus added. Resistance to wear is influenced by many factors and it is now generally agreed that, within the limits likely in engineering castings, resistance to wear increases with increasing phosphorus content. The drop in strength on annealing phosphoric irons is not so pronounced as in the case of non-phosphoric irons. Iron containing 1 per cent. phosphorus shows on dead-annealing about one-half the drop in strength found in a low-phosphorus iron under similar treatment. The decrease in hardness is about the same for both high- and low-phosphorus irons. Annealing increases the shock strength, and for a given composition the increase is similar for both high- and low-phosphorus irons.

When engineering grey irons are submitted to high temperatures they are liable to internal and external oxidation, leading to growth and scaling, but, in general, ordinary engineering grey irons (pearlite irons) will not be subjected to temperatures exceeding 350° C. Phosphorus does not materially influence liability to growth, but tends slightly to improve resistance to scaling. Tests on cast iron at elevated temperatures of sufficiently short duration to avoid creep and growth effects, show that as temperature rises to about 200-300° C. there is a slight fall in strength which is recovered at higher temperatures, so that at about 450-500° C. the strength is approximately that at air temperature, after which the strength again falls fairly rapidly. This change is true for tensile strength, hardness, and impact strength. Phosphorus does not appreciably modify this, nor does it materially alter the thermal expansion of a cast iron, but slightly lowers the thermal conductivity, the amount being about 0.5 per cent. for each 0.1 per cent. of phosphorus added.

Austenitic and Martensitic Irons

The report on austenitic and martensitic irons begins with an introductory statement relating to the character of the irons and the types of cast iron available. Austenitic cast irons are those in which the predominating constituent is austenite, the remaining constituent being graphite, except when the austenite-cementite eutectic fails to decompose to austenite and graphite, in which case they need softening treatment. They can be made by the addition of certain alloys to cast irons. Of these additions, nickel is the most important, and is the only known one capable by itself of rendering an iron austenitic without at the same time increasing the carbide content and hence giving an undesirably high proportion of eutectic in the structure. Cast irons of about 3.5 per cent. carbon and over 1 per cent. silicon become fully austenitic with an addition of 20 per cent. or more of nickel. Copper can be used to some extent to replace nickel, and chromium is a convenient means of increasing both the hardness and heat resistance. Irons can be made austenitic by the use of manganese, but at the expense of an undesirably high proportion of carbide.

In general, properties are discussed in relation to the well-established types of austenitic cast iron, on which most of the work available has been done. These are known as "Nomag," "Niresist" and "Nicrosil." Nomag, introduced primarily as a non-magnetic iron, normally contains 10 per cent. nickel and 5 per cent. manganese. Niresist is a nickel-copper-chromium iron, introduced primarily as a corrosion-resisting iron, but generally useful wherever austenitic irons are suitable, and the normal composition is 14 per cent. nickel, 7 per cent. copper and 2 per cent. chromium. Nicrosil is a nickel-chromium-silicon iron, introduced primarily as a heat-resisting iron, but also generally useful. The normal composition is:

nickel, 18 per cent., chromium 2 per cent., and silicon 5 per cent. Wide variations in these compositions can be made to suit special requirements.

Austenitic cast irons may be regarded as bearing the same relation to ordinary cast irons as some of the stainless steels bear to the ordinary steels. Although more expensive, both in raw materials and manufacture, the austenitic cast irons have properties which mark them off as different from all other cast irons, particularly in their softness and ductility; high resistance to wear, erosion, corrosion and heat; non-magnetism and relatively high electrical resistance; low thermal conductivity and high thermal expansion. Their mechanical properties compare with those of a good engineering cast iron, but their softness and toughness make them readily machinable. They are easily welded. They are not susceptible to ordinary heat treatment, *i.e.*, quenching and tempering, but nevertheless can be annealed at low temperatures with advantage. They can be cast white if required, and a simple thermal treatment such as annealing at 950° C. for 30 minutes yields a metal with 2.3 per cent. elongation in the cold. While the founding of these irons presents special problems, these can be overcome and the smallest castings made. They melt at about 1150° C., and have a specific gravity of 7.2-7.6.

Corrosion Resistance of Austenitic Irons

Considerable information is available on the corrosion resistance offered by austenitic cast irons, but results often vary considerably with the conditions of test, temperature and concentration of the corroding medium, and erosion effects. The loss is not necessarily constant with time. The corrosion of austenitic irons may vary from 1/1 to 1/500 of that of ordinary cast iron under the same conditions. Thus, after prolonged exposure to the atmosphere the corrosion of plain cast iron was 10 times that of Niresist. In aerated tap-water the ratio was about 9/1, and in water at 95° C. saturated with carbon dioxide, corresponding to bad boiler water, the ratio was 6/1. In various weak acids, the ratio was from 5/1 to 10/1, while in hot caustic soda the ratio was 14/1. In many instances the resistance of austenitic cast iron to corrosion is comparable with that of brasses and bronzes. Niresist containing 3.5 per cent. chromium showed one-fifth of the corrosion of plain cast iron in hydrogen sulphide gas at 96° C. In liquid salt at 815° C. the corrosion of the austenitic iron was one-third, and the scale formed one-tenth, during a period of 240 hours, and the growth after the same period about one-fifth of the corresponding values for plain cast iron. The corrosion ratios are based on loss of weight in mg/dm² per day. Austenitic irons do not offer anything like the same corrosion resistance to nitric as to other mineral acids, but are at least as good as grey cast iron. But austenitic steels and irons show a marked reduction in corrosion compared with pearlitic steels and irons. Where resistance to corrosion was called for, however, the necessity for employing nickel for austenitic structures instead of manganese was demonstrated.

On resistance to growth and scaling at high temperatures in an oxidising gas such as moist carbon dioxide, laboratory tests have shown that conditions which would cause an increase in volume of 30 per cent. in a good engineering iron, have shown a volume increase of 1.4-2 per cent. in soft, and 0.5-1.0 per cent. in hard (higher chromium), Nicrosilal. The weight increase in the soft grade was 0.2 per cent. and in the hard grade 0.04-0.1 per cent. Soft Nicrosilal increased 1 per cent. in volume after two heats in moist carbon dioxide at 1000° C. Comparative tests on bars of various materials in a gas, muffle at 1000° C. showed that a soft grade of Nicrosilal was practically unharmed after the treatment and had a growth of 1.3 per cent. which was about one-fourth of the normal thermal expansion of the metal up to this temperature. A good engineering cast iron under the same conditions grew to the extent of 16 per cent. Tests in the U.S.A. have shown that Niresist at 650°-815° C. has ten to twelve times the resistance to oxide formation of plain cast iron in oxidising atmospheres.

Martensitic cast irons may be produced by heat treatment of an ordinary engineering pearlitic iron; or they may be specially produced and so treated that either of two varieties can be obtained. In one such variety the eutectic filling surrounding the primary grains is allowed to solidify white (cementitic), and in the other it is allowed to solidify grey (graphitic); they are respectively described as "white" and "grey" in character, the former being the harder of the two. The "grey" variety can be made martensitic in the condition as cast, or alternatively a martensitic structure can be produced in it by suitable heat treatment. Their resistance to wear, erosion, and abrasion has brought about their employment in a number of engineering applications.

While a great deal of experimental work has been done on the production of the grey variety, the greater industrial need has been for the harder variety, and it is for this type that the bulk of the information recorded is available. The type is best known as "Nihard." The essential feature of the composition is about 4.5 per cent. nickel and 1.5 per cent. chromium; the other elements resemble those in chill-cast irons, the silicon being relatively low. For the highest hardness, the carbon content is raised to a maximum, and for the highest strength it is lowered to a minimum; while in general the carbon and silicon contents are higher in small (and hence in rapidly cooled) castings, and vice versa. Nihard irons are not usually required for their resistance to corrosion or heat, but for their resistance to wear, erosion, and abrasion. They have six to eight times the abrasion-resistance of ordinary unalloyed white cast iron. They do not offer any increase in ductility or elongation over the ordinary engineering grey irons.

A CHEMIST'S BOOKSHELF

AN OUTLINE OF METALLURGICAL PRACTICE, (2nd Ed.). By Carle R. Hayward. London: Chapman and Hall. Pp. 690. 38s.

This second edition will satisfy two demands. It meets the desire of many engineers for a quick reference book that will give modern practice in extracting and refining, and it gives general information on the sources, uses and important alloys of the metals. It will assist students starting their metallurgical studies with no practical experience and little or no knowledge of the subject or its literature. The twenty-five chapters deal with copper, lead, zinc, aluminium, nickel, tin, mercury, antimony, arsenic, bismuth, cadmium, cobalt, magnesium, beryllium, gold, silver, platinum, chromium, tungsten, manganese, vanadium, molybdenum, zirconium, iron and steel, and finally with non-ferrous alloys.

Copper is treated at much greater length than the other non-ferrous metals, as certain general operations are described and illustrated here and merely referred to at later points. The stages by which most metals are produced are described under the following heads: (1) Mining, or the removal of the ore from its natural position in the earth's crust. (2) Concentration, or the separation of the minerals in the ore into two or more groups. (3) Roasting of sulphide ores or concentrates; oxide ores do not require this treatment. (4) Smelting, or the fusion of a rich ore or concentrate to obtain a crude metal or matte. (5) Refining, or the final elimination of impurities from the product of smelting, by fire, by electrolytic or chemical processes, or by distillation.

The book is abundantly illustrated with photographs and drawings supplied by institutes and companies engaged in metallurgical work. Each chapter gives the physical, mechanical and alloying properties as well as the chemical behaviour of the metal with which it deals. This book can safely be described as a standard work on its wide subject and it is obviously a valuable addition to the literature on process metallurgy to be highly recommended to metallurgists and engineers. Each chapter also offers advice for supplementary reading, including periodicals and annuals dealing with the different metals.

General News

Specialised courses in advanced chemistry will be available at the Bradford, Huddersfield, and Leeds Technical Colleges, beginning October 6, September 18, and October 3 respectively.

All correspondence to Coty (England), Ltd., should now be addressed to 41 High Street, Leighton Buzzard, Beds., as "Coty House" is undergoing repairs. Tel.: Leighton Buzzard 2383.

"Diplomas" in foremanship will be available for men who pass an examination after attending free courses, organised by the Government, in technical colleges. The courses will instruct on general principles of foremanship, supervision, production and planning, costing, remuneration, and labour management.

A fatal accident to two Royal Ordnance Factory operatives engaged on a contractors' plant in the North of England was announced by the Ministry of Supply last Saturday. A tank of ammonia exploded, and the fumes were so dense that the workers in buildings near had to be evacuated. When the fumes were cleared the two men were found dead.

The Ministry of Labour and National Service have issued two pamphlets entitled "Training for War Work in the Engineering Industry." They describe conditions of work, wages, allowances, and the courses available at Government training centres for men and women over 19 and those under that age.

Changes in the Schedule of Reserved Occupations announced by the Ministry of Labour last Tuesday include a number of new reservations. Foremen, composition makers, mixers, dippers, and certain machine operators employed in match manufacture are now reserved at 35; and the reserved age of certain classes of steelworkers has been lowered to 18.

The Government distribution allowance of 28s. a ton, made to encourage farmers to place early orders for sulphate of ammonia, has been withdrawn. Limited quantities held in storage by agricultural merchants must be resold to farmers with the following allowances: For delivery in August 22s. September 16s., October 10s., November 6s., and December 2s. a ton.

The queue habit has spread to National Savings. At a conference of group secretaries at Bishop Auckland, in South Durham, several turned up half-an-hour before time, and ten minutes before the hour fixed, the room was full and a queue forming in the corridor, necessitating an adjournment to the largest hall available. The meeting decided to raise £100,000 before October 4.

Under a Ministry of Supply Order (S.R. & O., 1941, No. 1010), which came into force on July 17, all iron products except pig-iron, but including iron castings, are incorporated in the distribution of steel supplies scheme with effect from September 1. All existing orders must have been authorised by the responsible Government Departments at that date. Small purchases of certain materials are exempt. Maximum prices fixed are in the main unaltered.

The aid of metallurgists is being sought in a new flying problem—the conquest of the sub-stratosphere. Owing to the thinness of the air in that layer of the atmosphere, aero engines have to be assisted by superchargers, and great advances have been made in this direction. A turbo-supercharger working off the exhaust is employed by the American in the high-flying Fortress, for example, and complete success here can be ensured if a metal can be found that will withstand the great heat given off.

The quality of English herbs this year will be good, the quantity short, and the prices advanced, owing to the cost of labour and fuel, according to the recent crop report of Messrs. Potter & Clarke, Ltd., London and Manchester. What appeared, about a month ago, to be a very promising season is not now the case because, although we had good rains in June, the very dry weather setting in afterwards has not given the plants an opportunity to grow. Many herbs, too, were affected by the cold spell in April and May and will be much scarcer than last season. All crops, however, are remarkably free from blight.

From Week to Week

The Chemical Manufacturers' Directory of England, Scotland, and Wales, for 1941, published by Messrs. Simpkin Marshall (1941), Ltd., London, has been issued without reduction to size or alteration of contents. The price has been raised by 1s. to 5s. 6d., but the Directory will prove to be just as indispensable as in the past. Incidentally, this is the 73rd edition, and the editor and his staff are to be congratulated on maintaining the standard of their production through the past difficult year at so trifling an increase in cost.

Foreign News

Exports of columbite ore from Nigeria during the last quarter of 1940 were 150 tons. Over the whole year 396 tons were produced and 250 tons were exported, all to the United States. Ample supplies of the ore are available.

Investigations of the recent disturbance at the Arvida (Que.) works of the Aluminium Co. of Canada are proceeding, and steps have been taken to avoid unnecessary delays in the event of similar future occurrences. Enemy sabotage is suspected and the shut-down will cause a three weeks' loss of production.

The Leuna Chemical Works, near Leipzig, according to reports from a Central European source (quoted by the Moscow wireless), were heavily damaged by fire which broke out on July 17, at 3 a.m. Production is still at a standstill. There were a number of casualties.

The United States Government has provided a number of educational centres for training students, with a minimum of two years' experience in chemistry or engineering, where they may receive a twelve weeks' course on explosives and ammunition.

Southern Rhodesia's mineral output for the first half of 1941, Reuter reports, is valued at £1,499,000, a small advance on the corresponding period last year. The total June value of mineral production amounted to £740,000, including £179,000 of base minerals.

Cresylic acid imports into Peru, almost entirely for disinfectant manufacture, showed a marked decline in 1940. Figures quoted for the first ten months of that year show an aggregate of 9200 kg., as against 30,434 kg. for the whole of 1939. The U.S.A., Germany, and the U.K. are normally the chief supplies.

A second plant for producing toluol from petroleum is being erected by the Shell Oil Co. at Houston, Texas, duplicating the one that was opened last December. The new plant is expected to be ready by October 1, and the combined annual capacity of the two will be four million gallons.

The shortage of copper sulphate recently reported from the United States appears to have been due principally to the greatly increased demand for this versatile chemical in latter years, notably from agricultural, germicidal, and electroplating quarters. The demand is likely to be soon met, however, by a steady rise in the actual amount of copper mined in America, and the accompanying increased production of the sulphate.

The United States consumed more bauxite during 1940 than in any previous year, according to the Bureau of Mines. Apparent domestic consumption in 1940 was 958,695 long tons, 22 per cent. more than the 782,975 tons consumed in the previous peak year of 1939. Domestic bauxite output in 1940 totalled 438,913 long tons (dried ore basis), and was valued at \$2,578,968, an increase of 17 per cent. in quantity and 19 per cent. in value over that in 1939. It is expected that 1941 will create new records in both production and consumption.

Forthcoming Events

The London Section of the Oil and Colour Chemists' Association will hold a meeting on August 7, at 7 p.m., at the Federation of British Industries, 21 Tothill Street, S.W.1., when Mr. Sidney J. Johnstone, B.Sc., F.I.C., Principal of the Mineral Resources Department of the Imperial Institute, will give an illustrated lecture on "Minerals for the Paint Industry."

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

GRANO-METALLIC PAVING AND PLASTERING CO., LTD., London, E. (M., 2/8 41.) July 3, charge to Westminster Bank, Ltd., securing all moneys due or to become due to the Bank, charged on land and factory at Shelley Road and land at Beaumont Road, Leyton, with fixtures. *£7,000. Dec. 19, 1940.

LANGLEY SHAW AND CO., LTD., Yeading, dealers in textile detergent compositions. (M., 2/8 41.) July 7, £800 (not ex.) mortgage, to Lloyds Bank, Ltd., charged on Henshaw Lane Works, Yeading. *Nil. Aug. 22, 1940.

PLASTILUME PRODUCTS, LTD., High Wycombe. (M., 2/8 41.) July 12, £1,200 debenture to Branch Nominees, Ltd., general charge, ranking pari passu with debenture dated Feb. 23, 1940, and subject to charge dated Nov. 12, 1940. Jan. 13, 1941.

VICTOR WOLF, LTD., Manchester, glycerine manufacturers (M., 2/8 41.) July 7, debenture to Lloyds Bank, Ltd., securing all moneys due or to become due to the Bank; general charge. *£5,000. Dec. 2, 1940.

Company Winding-Up Voluntarily

LANDORE ZINC, LTD. (C.W.U.V., 2/8 41.) By extraordinary resolution, July 17, George Morgan Davies of 28 Rutland Street, Swansea, and Leslie Stewart Findlay, of 35 Windsor Place, Cardiff, appointed liquidators.

Company News

Nordac, Ltd., have increased their nominal capital beyond the registered capital of £2000, by the addition of £8000 in £1 ordinary shares.

The Anglo-Greek Magnesite Co., Ltd., announce a profit for 1940 of £21,211 (£19,271), and recommend a final dividend of 5 per cent., making 8 per cent. (same).

The directors of **Benn Brothers, Limited**, proprietors of THE CHEMICAL AGE, announce dividends for the year ended June 30 of 3 per cent. on preference shares, making 6 per cent.; 8 per cent. on ordinary shares, making 12 per cent. (same); and 2s. 4 1/2d. on deferred shares (same), all less tax.

New Companies Registered

Bedford Metal Company, Ltd. (368,068).—Private company. Capital, £1000 in 1000 shares of £1 each. Metallurgists, metal foundry, steel makers, metal and alloy makers, refiners, experimental, consulting, chemical and general engineers, sheet metal workers, metal stampers, die casters and sinkers, art metal workers, manufacturers of and dealers in plant and apparatus of all kinds, etc. Subscribers: Elliott A. Mellor; John E. Young. Registered office: 24a Friar Street, Reading, Berks.

Chemical and Allied Stocks and Shares

EARLIER in the week sentiment on the Stock Exchange was dominated by the new developments in international affairs resulting from Japan's action in Indo-China. As a precautionary measure, a certain amount of marking down of prices was in evidence, but declines were moderate on balance, although the volume of business was very small. On the other hand, markets were encouraged by the fact that no heavy selling developed. In fact, many securities remained in small supply owing to the firmness with which they continued to be held. Subsequently, the general tone tended to improve under the lead of British Funds, and industrial securities showed a firmer tendency, the slightly lower prices made earlier in the week having attracted some attention, partly

because recent dividend announcements and results have been in accordance with market expectations.

Imperial Chemical at 31s. 6d. were within 3d. of the price ruling a week ago, and the 7 per cent. preference units made the moderately higher price of 32s. 3d. General expectations are that the interim dividend, due to be announced in September, will be maintained at 3 per cent., and the view prevails that there seem reasonable possibilities of the total I.C.I. dividend being kept around 8 per cent. during the period of the war. Lever and Unilever remained steady at 25s. on the possibility of a distribution, if the dividend equalisation agreement between the English and Dutch companies were to prove not legally binding in view of the invasion of Holland. Borax Consolidated at 28s. 6d. were again a steady feature, as were British Match at 34s. 6d., and Turner and Newall at around 71s. Moreover, Allied Ironfounders held their recent improvement at 18s. 6d., and elsewhere. Barry and Staines rose further to 30s. 9d., while Nairn and Greenwich were steady at 56s. 3d. Some attention has continued to be given to General Refractories shares, which showed another small gain to 9s. 7 1/2d., compared with 9s. 4 1/2d. a week ago. Attention was also given to Imperial Smelting, which at 11s. 3d. were again higher on hopes of better results for the past financial year. Goodlass Wall 10s. shares transferred around 9s. 6d., while British Aluminium at 45s. were 3d. better on the week; the market view is that the interim dividend, due to be announced in September, will be kept at 3 per cent. The interim of Associated Cement is generally expected to be unchanged at 5 per cent., but the shares at 55s. were slightly lower as compared with a week ago, although in other directions British Plaster Board 5s. ordinary had a firm appearance at 16s. British Oxygen were steady at 66s. 6d., but on balance, the ordinary units of the Distillers Co. went back from 65s. 3d. to 64s. 9d., and British Oil and Cake Mills preferred ordinary further eased from 40s. to 39s. 4 1/2d. Movements in iron, steel and allied securities were moderate in character, and some declines were shown on balance, although United Steel later became firmer at 23s. 6d. and Stewarts and Lloyds and Tube Investments were firm at 45s. 9d. and 94s. 3d. respectively.

Business in Fison Packard was recorded at 33s. 9d. British Industrial Plastics 2s. shares transferred up to 2s. 10 1/2d., while Morgan Crucible 5 per cent. second preference changed hands at 20s. 6d. Erionid shares were dealt in at 4s. at one time. In other directions, Boots Drug 5s. ordinary developed an easier tendency at 35s. 6d.; although there are doubts in the market whether there will be a resumption of cash bonus payments during the period of the war, there is general confidence that the dividend rate is likely to be maintained. Beechams Pills 2s. 6d. deferred made the higher price of 8s. 9d.; publication of the full results for the past year's working is expected shortly. There were few movements among textile securities, although British Celanese second preference improved to 13s. 10 1/2d., and aided by the maintenance of the interim dividend at 2 1/2 per cent., Courtaulds had a firmer appearance at 30s. 4 1/2d. In accordance with the general tendency "Shell" and other leading oil shares subsequently developed a better tendency than that ruling earlier in the week.

British Chemical Prices

Market Reports

A FIRM tone characterises nearly all sections of the general chemicals market, and almost without exception contract deliveries are being called for in good quantities. Trade during the past week both for home and export account has been influenced by the scarcity of spot offers, and a fair volume of inquiry is reported to be in circulation. There have been no price changes of importance although the tendency in some directions is towards higher levels. Moderately active conditions have been reported from the coal tar products section with quoted rates for one or two items a little firmer.

MANCHESTER.—With one or two exceptions there has been little contraction during the past week in the demand for contract deliveries of heavy chemicals on the Manchester market. Paper-making chemicals, as they have been for some time, are a relatively quiet section, but there is a fairly steady call for supplies from the rubber trade, and also from the textile and allied branches. Firm price conditions remain in virtually all sections. In the by-products market a generally well-sold position is reported, and it is not easy to meet fresh requirements, especially in the light distillates and in tar, cresote oil and carbolic acid.

GLASGOW.—There is no change in the Scottish heavy chemical trade. Home business remains steady, and export inquiries are rather limited. Prices remain firm.

